Motivating Mathematics

Honors Thesis (HONR 499)

By

Elizabeth Scheiber

Thesis Advisor

Crystal Lorch

Ball State University
Muncie, Indiana

October 2018

Expected Date of Graduation

May 2019

Abstract

Student interest and motivation are vital components of academic success. In secondary mathematics classes, teachers should be doing everything they can to make the content engaging, exciting, and relevant to the students. Studies show that when these needs are met, students perform better and retain information longer. Project-based learning is an excellent way to engage students with the content, which is why I chose to create an example project that shows mathematics teachers how to make a lesson on linear functions appeal to their students' interests. Students practice real-life skills when completing a project, which helps them understand the importance of mastering the content.

Acknowledgements

I would like to thank Crystal Lorch, my advisor for this project. She spent so much time discussing the project with me and helping me figure out what my goals were. She was always available to answer questions I had throughout the project. I would also like to thank Dr. Kathryn Shafer and Mr. Bill Reed for their help throughout the project. These three individuals made this project possible, and I am so grateful.

Table of Contents

Process Analysis Statement

I have known a lot of students who dislike mathematics. It is difficult to reach those students. Over the past four years, I have taken so many classes that stress the importance of engaging my students. We discussed different ways to engage students, including cooperative learning strategies and integration of technology. Unfortunately, we never discussed how to make mathematics seem relevant to students. In my opinion, that is one of the most important parts of being a math teacher. However, that is only one reason that I was inspired to research student interest and motivation.

Another inspiration for this project came from my experience in New Tech through high school. New Tech is an alternative approach to education that focuses on project-based learning. The classes I was enrolled in throughout high school had a business-like structure. Each project was completed in groups, and group members were held accountable by using group contracts. The students were each assigned a role, such as team leader or rubric monitor, to make sure the project was progressing smoothly. As students, we were responsible for our own learning. My experience in New Tech opened my eyes to how creative teachers can be with curriculum. This experience has motivated me to become the type of teacher that strives to keep my students interested in the content. For that reason, I was inspired to create a project that shows students how mathematics is relevant in their daily lives.

I started the process by reading journal articles and research studies that supported my claim that student interest directly impacts academic success. After verifying that my ideas were accurate, I began creating the example project, which I titled *Planning a Vacation*. I decided to create the project before the research paper because I wanted to be sure that I could do what I am asking other teachers to do, which is to make mathematics more interesting for students. Creating the project was challenging. I originally wanted to base the project on a career, but I was struggling to find a career for which I had enough background knowledge. I began thinking about projects that I completed in New Tech in high school, and I remembered an Algebra II project that modeled the value of a car over time using an exponential function. We were able to choose the car of our choice, which made each student's data unique. That is what inspired me to create a project where students planned their own vacation and had to track expenses over time.

Once I finished designing the project, my advisor suggested that I complete the project myself. I had to plan my own vacation to make sure the project would actually work. This was really exciting for me, as I was able to directly experience the process my students would go through when completing the project that I designed. Throughout that process, I found small parts of the project that needed clarification or corrections. It was a great way to reflect on what errors my students might make if I was not clear enough in the instructions.

After that, I began working on a lesson plan for one day of an Algebra I class. I wanted to include the lesson plan so that I could show other teachers how I thought the project should be introduced. There should be a time for review and discussion before starting a project to make sure that the students all understand what they are supposed to be doing. I also wanted to make sure I had a place to include options for the teacher when it came to the project. I realize that not every class is the same, and differentiation is important for instruction, so I knew that it was important to consider that when making the project. I wanted the teachers to have options based on the behavior of the students, as well as their own preferences.

My last step was to write the research paper. When I first decided on my thesis topic, I struggled with whether or not I wanted to write a research paper along with creating a project. I decided to write the paper so that I could explain my motivations for creating the project, as well as explain to future and current teachers why I believe mathematics courses need to be remodeled. I knew that there was something fundamentally wrong with teaching mathematics without considering its relevance for students, and I wanted to demonstrate that it is possible to make mathematics more fun and engaging. The most difficult part of writing the research paper was trying to put all of my findings in a logical order. I found an incredible amount of evidence to support my argument, but I did not know exactly how to put all of that together. This part of the thesis project took me the longest, but it was the most meaningful because it taught me a lot about how to be a better teacher in the future.

My favorite part of this entire process was putting my beliefs about mathematics education into words. I was able to make my ideas become a reality, and that is such an amazing feeling. Creating a lesson plan that incorporates project-based learning was a new experience for me, but it was so much fun. I am looking forward to creating many more like it so that I constantly have an answer for the student who asks me when they are ever going to use the content. Throughout this process, my goal as a teacher has shifted from becoming the fun, relatable teacher to becoming the teacher who cares about my students' interests, their engagement with the content, and their academic success. I found a whole new passion within my career, and I am excited to see where this takes me.

I would love to see other teachers use the ideas that I present in this thesis. My intention in creating the example project was not only to provide teachers with a project they can actually use, but also to inspire them to create more projects that have similar goals. I would love to look back one day and see what other lessons teachers have created that use project-based learning to motivate their students.

Motivating Mathematics

It is no secret that many secondary students tend to have negative feelings toward their mathematics classes. Overcoming this is a challenge that all mathematics educators face at some point in their careers. Many mathematics teachers seek to be enthusiastic about the material and also to help their students enjoy the content. However, teachers cannot force their students to enjoy a subject, especially if they have already hated it for many years. Often, teachers aim to be viewed as fun. Perhaps, instead, they should endeavor to make the content itself more fun for students.

Consider what the typical high school mathematics classroom looks like. The students are sitting at their desks, which are lined in rows across the classroom. The teacher is standing at the chalkboard writing example problems and definitions for the students to copy into their notes. Content is being gone through so fast that many students struggle, which leads to feelings of defeat. Nothing the students are being taught seems relevant, so one of the students raises his hand and asks, “When am I ever going to use this?” The teacher is at a loss for words, unable to find an exact moment in the student’s life when he will use slope-intercept form to solve a problem that did not come out of a textbook.

Students from all over the United States leave their mathematics class every day believing that what they were just taught has absolutely no point. They do not believe that the information is valuable in everyday life. They memorize the information to pass the test, and then they forget it because they do not see the value. Because of that, an excellent goal for a teacher is to motivate students to learn by making mathematics relevant in their lives. It is important to show students that mathematics can be fun, exciting, and interesting by relating the content to things that excite them: their hobbies, their future careers, and so much more. Using project-based learning, students will use mathematical concepts to develop skills that will be useful in their futures. Not only will this make learning more interesting for the students, it will make teaching more fun for educators. Students will understand the importance of mathematics, as well as its relevance in their daily lives, and they will be more motivated to participate in class.

When student interest is low, their achievement in mathematics, or in any other class, suffers. On the other hand, when they are excited about the lesson, they will care more about the content and retain the information longer. Because of that, it is essential to make mathematics as relatable as possible for students. One way to do so is by creating projects that utilize important skills, discuss careers, and explore hobbies to show students how mathematics applies to their lives. Throughout this paper, student interest and motivation will be discussed. An example lesson plan and project will be presented. This project focuses on one of the most critical Algebra I standards on the ISTEP+ exam. The research and project itself are suitable for teachers to incorporate into their classrooms in an effort to make their own classes more relevant and exciting for their students.

Mathematics is a subject that is full of connections. Each lesson taught builds off of previous lessons. Each concept introduced builds upon prior knowledge. Everything done in mathematics classes is somehow related to something already done in the past. Mathematics teachers are trained to help students see and understand connections between different mathematical concepts. Teachers show students connections within the content on a daily basis. However, mathematics teachers are not helping their students understand the connections between the content and their lives.

When students cannot see the relevance of what they are learning, it makes it really easy to lose focus. Some teachers might argue that they have too much content to cover in a short period of time, so it is up to the student to make those extra connections. Without guidance, though, it can be incredibly difficult for a student to relate the content to their lives. It can be even more challenging if they have never seen the content before. Teachers need to be helping them form these types of connections. People do not expect a small child to immediately understand that learning the alphabet will someday help them learn to write. Similarly, they should not expect a middle school student to immediately understand that learning to solve equations might help them estimate how much money they are going to make in a week at their new job.

By helping students form connections between mathematics and life, teachers are making the content seem more relevant and important. The students will, in turn, be more engaged and interested in what they are learning. Ella Kahu, Karen Nelson, and Catherine Picton (2017) determined that "individual interest is one of the student's psychological influences that acts as a motivation" (p. 57). When students are interested in what they are learning, they are more motivated to succeed.

The problem is that students are simply not engaged in mathematics classes. Part of a teacher's job is to question what can be done to make the class more student-centered while still preparing students for standardized tests. Students need to enjoy the class, but they still need to learn the material. It is believed that increased engagement happens when the lessons incorporate students' interests and goals, when the teacher is passionate and enthusiastic, and when the activities within those lessons are exciting (Kahu et al., 2017, p. 61). There are countless opportunities for engagement and enthusiasm in project-based learning.

Duke University completed a study that focused on student interest. According to the article, “the studies examined the notion that your level of interest helps to simultaneously optimize your performance and the resources necessary to stay deeply engaged” (“Why Interest,” 2014). During the study, students were asked to complete puzzles and later explain whether or not they found that task to be enjoyable. Later, they had to complete puzzles that were valuable to them. It was found that the students performed better when they believed the task was valuable (“Why Interest,” 2014). Paul O’Keefe, one of the researchers who conducted the study, stated:

> We not only showed that those who found the task enjoyable and important performed among the best, as they did before, but they also squeezed the grip the longest. In other words, they solved the most problems and it wasn’t mentally exhausting for them (“Why Interest,” 2014).

A similar idea applies in mathematics classes. Students who see the content as relevant to their personal and professional lives will be more interested in the content, more motivated to learn, and will retain the information longer as a result.

There are multiple ways to make mathematics seem more relevant to students, and project-based learning is just one. Here, teachers can create projects that involve real-world problems for the students to solve. The students will be practicing valuable skills and learning about things that go beyond the classroom. Project-based learning also provides an opportunity for students to create a product of some sort, whether that is a visual aid for a presentation or an item that showcases what they have learned throughout the unit.

In many education methods classes, professors discuss the importance of Bloom’s Taxonomy, a pyramid that categorizes educational objectives. At the top of this pyramid is

"Create" (Armstrong, 2018). At this level, students are designing something, forming a conjecture, investigating a problem, or something else along those lines. In project-based learning, students are asked to do one or more of those things. This encourages understanding and retention. The second level is "Evaluate" (Armstrong, 2018). Here, students have to justify a decision. They must form arguments and use details to defend their arguments. The third level, "Analyze," has students focus on forming connections between different concepts or ideas (Armstrong, 2018). At each level, students are performing different tasks. As one moves up the pyramid, the tasks require an increasing amount of effort from the students, as well as the teacher. Project-based learning uses every level of Bloom's Taxonomy to help students of all learning styles retain the information and perform well. The fact that project-based learning asks students to create something is vital here. In most cases, when creating a product of some kind, students are given a choice about how that product will turn out. Incorporating student choice into an assignment or project is a great way to increase student interest and motivation. That alone increases their chance for success. Hootstein (1994) wrote:

> Teachers should provide students with opportunities for social interaction, hand-on experiences with finished products, and physical movement; provide opportunities that allow students to perceive a sense of control in their learning activities; and make learning relevant by relating the content to the students' needs, goals, interests, values, and experiences (p. 216).

While creating the example project, it quickly became apparent that designing a project that makes mathematics relevant to students' lives can be very difficult. However, this is something that needs to be done. The project needed to serve as a model for other teachers, incorporating the ideas and conclusions from research while still having a strong focus on the content. The whole point of the example project is to increase student interest about the concepts students are required to learn, not eliminate the concepts they are less interested in. However, the hardest part about designing a project for the purpose of exemplifying these beliefs was deciding which concept to cover in the project.

In Indiana, students are required to pass the ISTEP+ Algebra I Exam to graduate high school. The Indiana Department of Education publishes information about the exam. Mr. William R. Reed, a Secondary Math Specialist at the Indiana Department of Education, was kind enough to send the blueprint for the ISTEP+ math assessment. This document shows which Algebra I standards will be tested over, as well as what percentage of questions on the exam are from each standard (Reed, 2018). For the purposes of this project, it seemed most useful to focus on the most critical standard on the exam. This standard is associated with the largest portion of questions on the ISTEP+ exam, so it would be most useful for teachers. This standard was AI.L.4, which states, “Represent linear functions as graphs from equations (with and without technology), equations from graphs, and equations from tables and other given information (e.g., from a given point on a line and the slope of the line)” (“Mathematics,” 2018).

In order to complete the example project, students must have some prerequisite knowledge about linear functions. They must understand the different forms of linear equations and be able to write a linear equation in slope-intercept form. They must also be able to graph a linear function from its equation written in slope-intercept form. Throughout the project, they practice both of those skills. To make sure that students are all ready to move on to the project, the class begins with a bell ringer activity that has them practice those concepts. Then, the students are asked to create a real-world situation that can be modeled by a given linear function from the bell ringer. The class will have a brief discussion about the examples that students create, and the teacher will complete an example problem if the class is still struggling with the concepts. Afterward, the class will transition to working on the project.

The project is designed in a way that allows teachers to decide how to implement it. Students may work in groups or individually. They may be asked to present their findings to the class. There might be a specific and limited list of choices given to the students, or the students might have freedom to make their own choices for the project. No matter what the teacher decides to do here, the project should be an effective tool for engaging students with a critical standard.

In the project, students are asked to choose a vacation destination within the continental United States. They have to do some preliminary research about their vacation destination and travel, but they are given certain prices to consider. The rest of the project asks them to plan expenses for their trip based on the information given to them, as well as the information they collected in the beginning. They must calculate how much money they need to save for a variety of expenses, such as food, travel, and lodging. The students also have to consider three different methods of travel. At the end of the project, the students compare the total cost of their vacations for the three methods of travel, then explain which method of travel they will choose and why. For each problem, the students must create a linear equation to represent the situation and graph that equation using either graph paper or technology, whichever is available.

There is student choice involved in this project, which automatically makes it more exciting for students. In addition, students are practicing skills that will be beneficial to them in the future. By using this project in the classroom, teachers show students that linear functions can be used to plan and create a budget for a vacation. These skills can be transferred to other things in their lives, such as planning for college. Should they live in a dorm or an apartment?

Should they purchase a meal plan on campus? There are so many uses for linear functions. Completing a project like this helps students recognize the relevance of the content, and it makes learning about linear functions more interesting for them. It is much more exciting than simply writing equations and graphing lines with no meaning behind the problems.

Student interest and engagement are key to academic success. As the Duke Today staff wrote, "Educators, managers, and parents, among others, should cultivate interest toward relevant activities in their students, employees, and children to facilitate their success" ("Why Interest," 2014). By relating mathematical concepts to something the students are interested in, they will be able to see the importance of mathematics in their daily lives. It would be impossible to find projects that interest every single student in every single class for every single unit, but that is not the point. The goal is not to put more stress on the teacher. Instead of trying to please every student every time, teachers need to attempt to appeal to the interests of every student at least once. If a teacher can show a student one time that mathematics is relevant and important in their everyday lives, then they are a successful teacher.

The next time a student asks when they are ever going to use mathematics, their frustrations will be understood. It will be obvious that it is important to find an example that shows students that the content is useful and relevant. Students should never feel as if what they are learning has absolutely no point. It is part of a teacher's job to ensure that students are successful learners and individuals. To increase students' chances of success, teachers need to make the content more exciting and engaging. It requires some effort, but the end result makes everything worth it. In a perfect world, both future and current mathematics educators will embrace this. Teachers all have to work together to make sure that our students do not lose interest or motivation in mathematics.

Sources

Hootstein, E. W. (1994). Motivating Students to Learn. *The Clearing House, 67*(4), 213-216. Retrieved August 20, 2018, from https://www.jstor.org/stable/30188799.

Kahu, E., Nelson, K., & Picton, C. (2017) Student interest as a key driver of engagement for first year students. *Student Success, 8*(2), 55-66. Retrieved August 20, 2018.

Why Interest Is Crucial To Your Success. (2014, April 16). Retrieved August 23, 2018, from https://today.duke.edu/2014/04/interest

Armstrong, P. (2018, August 13). Bloom's Taxonomy. Retrieved August 23, 2018, from https://cft.vanderbilt.edu/guides-sub-pages/blooms-taxonomy/

Reed, W. R. (2018, August 26). IDOE Question [Email to the author]. Blueprint for the Indiana ISTEP+ Grade 10 Math Assessment

Mathematics. (2018, August 8). Retrieved August 25, 2018, from https://www.doe.in.gov/standards/mathematics

Lesson Plan

Overview
Students should already understand how to graph a linear function, as well as how to find the equation of a linear function from its graph. Throughout this lesson, they will be creating linear equations based on given information, then graphing those equations. They will then complete a project using these skills. The standard the students will be working on has been identified by the Indiana Department of Education as the most critical Algebra I standard on ISTEP+.

- AI.L.4: Represent linear functions as graphs from equations (with and without technology), equations from graphs, and equations from tables and other given information (e.g., from a given point on a line and the slope of the line).

Objectives
- Students will be able to write a linear function to describe a given situation.
- Students will be able to graph a given linear function, both with and without technology.
- Students will be able to describe, both verbally and in writing, real-life situations that can be modeled using linear functions.

Procedures
These procedures are based on a 50-minute class.

1. In the first 5 minutes of class, have students complete a bell ringer activity that asks them to graph a linear function written in slope-intercept form.
2. For the next 5 minutes, have the students work in pairs to come up with a real-life situation that can be modeled using the linear function from the bell ringer. Go over these as a class to show how useful linear functions can be.
3. Have a brief discussion (5-10 minutes) to make sure everyone fully understands linear functions. For instance, students should understand how to identify independent and dependent variables within the word problem. The class should be aware of how to form a linear function from given information. This knowledge is essential for the project they will be completing. It might be helpful to do an example problem here if the students are still confused.
4. Pass out the "Planning a Vacation" project handout and make sure every student has access to either graph paper or an online graphing calculator that allows them to either screenshot or save their work. Let the students split up into groups of four or less. Each group must agree on one vacation destination to use for their project.
5. Allow students to spend the remaining class time (30-35 minutes) working on the project. This will give them a chance to ask questions if they arise. If the students do not finish the project in class, it should be completed as homework.
6. Students will present their projects to the class on the following class day.

Project Options

- If students work in groups on the project, it might be best to give them more time to work during the next day of class. It can be hard to finish a group project as homework.
- Different adaptations can be made to the project to adhere to the needs of the students and the teacher. Some of those changes are listed below.
  - Have students work individually instead of in groups.
  - If students work in groups, each group will present their entire project, including the data they collected, to the rest of the class.
  - If students work individually, each student will present specific information from their project, but not the entire thing (e.g., the destination they chose and the answers to Questions 7 and 8 on the handout).
  - Pick a list of five vacation destinations that the class may choose from to make grading easier.

Resources/Materials

- GeoGebra or Graph Paper
- "Planning a Vacation" Project Handout

Assessment/Evaluation

- Formative Assessment
  - The bell ringer will be graded for participation. It may help guide the discussion time during class by bringing misconceptions to my attention.
  - The discussion will not be graded. It will tell me which students are struggling, what they are struggling with, and then help me form a plan to help them.
- Summative Assessment
  - The project will be graded for accuracy. It will show whether or not students understand how to create a linear function to represent given information.

Planning a Vacation

Name: ______________________________

Today, you are going to be planning your very own vacation. Throughout this project, you will use linear functions to determine the cost of your vacation so that you can set a budget. Below are assumptions you need to make to complete the questions on this handout.

- The cost of a hotel is $150 per night.
- Gas costs $2.75 per gallon.
- Your car gets 25 miles per gallon of gas.
- You will eat three meals per day.
- A cab has a $3 boarding fee and then costs $2.70 per mile.
- You will need to plan one day to travel to your vacation destination, as well as one day to travel back home.

You need to do some research before beginning to track your expenses. You must choose a vacation destination within the continental United States, as there are questions about driving expenses that need answered later on. You must also choose a vacation destination that does not require additional travel (e.g., a rental car). Answer the following questions about your vacation.

1. Where are you going to go?

2. How many nights will you need to stay in a hotel?

3. Which airport is closest to your vacation destination, and how far is it (in miles) from your vacation destination?

4. How much would a plane ticket cost if you were to fly to the nearest airport? Use the Delta Airlines website to determine the cost of your ticket. You will need to consider the number of days you will be staying at your vacation destination, and you will need to find the price for a round-trip ticket. Will there be someone accompanying you on this vacation? If so, make sure to calculate the total price of your tickets together!

5. Does your vacation destination require a ticket to enter (e.g., a theme park)? If so, how much will that cost per person? Will there be someone accompanying you on this vacation? If so, make sure to calculate the total price of your tickets together!

6. How many miles (driving) is it from your house to your vacation destination? Use the Google Maps app to determine this. You may also want to take note of the amount of time it will take to drive there.

Using the assumptions above and information about your vacation that you already gathered, you will have several questions to answer below. You may use GeoGebra or graph paper to graph the functions you create. If you choose to use GeoGebra, you must save each graph individually and submit those electronically. Good luck and have fun!

1. Create a linear function to describe how much it will cost to ride in a cab. Graph this function. Based on the function you created, how much will a cab cost for you trip to the vacation destination and back? Be sure to consider the fact that you will need to pay the boarding fee twice here. Let x represent the number of miles and let y represent the cost for x miles in the cab.

2. Assume that you are taking an airplane to the airport closest to your vacation destination. How much would your transportation cost, including both the airplane and the cab? Again, be sure to consider the boarding fee for both trips in the cab. Modify the linear function you made in Question 1 to match this scenario. Graph this function.

3. Assume now that you are going to drive from your home to the vacation destination. Based on the number of miles you will need to drive and the gas mileage of your car, calculate how many gallons of gas you will use. Which variable is your independent variable? Create a linear function to represent how much gas will cost during your trip. Graph this function. How much money should you save to pay for the gas? Be sure to consider your trip home, too!

4. Create a linear function to represent the cost of your hotel over time. Do not include taxes or other fees, but only consider the price of the hotel that was given to you on this handout. Graph the function you create. How much money do you need to save in order to pay for your hotel? Let x represent the number of days and let y represent the cost of the hotel.

5. Create a linear function to represent the number of meals you will eat over time. Graph this function. How many meals do you need to plan for?

6. Create a linear function to represent how much money you need to save for meals, assuming you are going to budget $10 per meal. Graph this function. How much money should you plan to spend on meals for the entire trip? Be sure to consider your travel days.

7. Using the information from the previous questions, determine the cost of your entire vacation. You will need to write three answers here: one for the scenario in which you take a cab from home to the vacation destination, one for the scenario in which you drive the entire way, and one for the scenario in which you ride in an airplane and then take a cab from the airport to the vacation destination.

8. Based on the information from Question 7, as well as your own feelings about travel, what is your preferred method of travel and why?

Planning a Vacation

Name: Student

Today, you are going to be planning your very own vacation. Throughout this project, you will use linear functions to determine the cost of your vacation so that you can set a budget. Below are assumptions you need to make to complete the questions on this handout.

- The cost of a hotel is $150 per night.
- Gas costs $2.75 per gallon.
- Your car gets 25 miles per gallon of gas.
- You will eat three meals per day.
- A cab has a $3 boarding fee and then costs $2.70 per mile.
- You will need to plan one day to travel to your vacation destination, as well as one day to travel back home.

You need to do some research before beginning to track your expenses. You must choose a vacation destination within the continental United States, as there are questions about driving expenses that need answered later on. You must also choose a vacation destination that does not require additional travel (e.g., a rental car). Answer the following questions about your vacation.

1. Where are you going to go?
   I am going to go to Disney World in Orlando.

2. How many nights will you need to stay in a hotel?
   My vacation will be four days long, so I will stay in a hotel for five nights.

3. Which airport is closest to your vacation destination, and how far is it (in miles) from your vacation destination?
   Orlando International Airport (MCO) is closest. It is 19 miles from Disney.

4. How much would a plane ticket cost if you were to fly to the nearest airport? Use the Delta Airlines website to determine the cost of your ticket. You will need to consider the number of days you will be staying at your vacation destination, and you will need to find the price for a round-trip ticket. Will there be someone accompanying you on this vacation? If so, make sure to calculate the total price of your tickets together!
   A round trip ticket from the Fort Wayne Airport, which is the closest airport to my house, to Orlando would cost $617.60. My boyfriend will go with me, so our tickets will cost $1235.20 together.

5. Does your vacation destination require a ticket to enter (e.g., a theme park)? If so, how much will that cost per person? Will there be someone accompanying you on this vacation? If so, make sure to calculate the total price of your tickets together!
   I am going to take my boyfriend with me, so I will need two tickets for the park. We decided to get the Park Hopper Plus tickets. One ticket will cost $511.20 after tax. The total for both of us would be $1022.40 after tax.

6. How many miles (driving) is it from your house to your vacation destination? Use the Google Maps app to determine this. You may also want to take note of the amount of time it will take to drive there.
   According to Google Maps, Disney is 1079 miles from my house. The app says that it would take 15 hours and 43 minutes to drive there.

Using the assumptions above and information about your vacation that you already gathered, you will have several questions to answer below. You may use GeoGebra or graph paper to graph the functions you create. If you choose to use GeoGebra, you must save each graph individually and submit those electronically. Good luck and have fun!

1. Create a linear function to describe how much it will cost to ride in a cab. Graph this function. Based on the function you created, how much will a cab cost for you trip to the vacation destination and back? Be sure to consider the fact that you will need to pay the boarding fee twice here. Let x represent the number of miles and let y represent the cost for x miles in the cab.
   The function that represents the cost of a cab is $y = 2.7x + 3$. Since I need to consider the trip there and back, I will evaluate this function for 1079 miles and then multiply that result by 2. So, based on that, it will cost me $5832.60 to take a cab from my house to Disney and back. See Graph 1.

2. Assume that you are taking an airplane to the airport closest to your vacation destination, then taking a cab to the vacation destination. How much would your transportation cost, including both the airplane and the cab? Again, be sure to consider the boarding fee for both trips in the cab. Modify the linear function you made in Question 1 to match this scenario. Graph this function.
   I need to add the cost of my plane ticket and another $3 for the second boarding fee for the cab to my function from the last question. This would make my function $y = 2.7x + 1241.20$. I will evaluate this for 38 miles since the airport is 19 miles from Disney. My transportation would cost $1343.80 total. See Graph 2.

3. Assume now that you are going to drive from your home to the vacation destination. Based on the number of miles you will need to drive and the gas mileage of your car, calculate how many gallons of gas you will use. Which variable is your independent variable? Create a linear function to represent how much gas will cost during your trip. Graph this function. How much money should you save to pay for the gas? Be sure to consider your trip home, too!
   I will use 43.16 gallons of gas going from home to Disney, so I will use a total of 86.32 gallons. The function that represents the cost of gas would be $y = 2.75x$, so I would need $237.38 to pay for gas for the entire trip. See Graph 3.

4. Create a linear function to represent the cost of your hotel over time. Do not include taxes or other fees, but only consider the price of the hotel that was given to you on this handout. Graph the function you create. How much money do you need to save in order to pay for your hotel? Let x represent the number of days and let y represent the cost of the hotel.
   The function to represent the hotel cost would be $y = 150x$, and I am staying five nights, so I would need to save $750 for the hotel. See Graph 4.

5. Create a linear function to represent the number of meals you will eat over time. Graph this function. How many meals do you need to plan for?
   The function that represents the number of meals I will eat is $y = 3x$. With four days of vacation and two days of travel, totaling six days, I will eat 18 meals. See Graph 5.

6. Create a linear function to represent how much money you need to save for meals, assuming you are going to budget $10 per meal. Graph this function. How much money should you plan to spend on meals for the entire trip? Be sure to consider your travel days.
   The cost of my meals can be represented using the function $y = 10x$. For 18 meals, that means I should plan to spend $180 on food during my trip. See Graph 6.

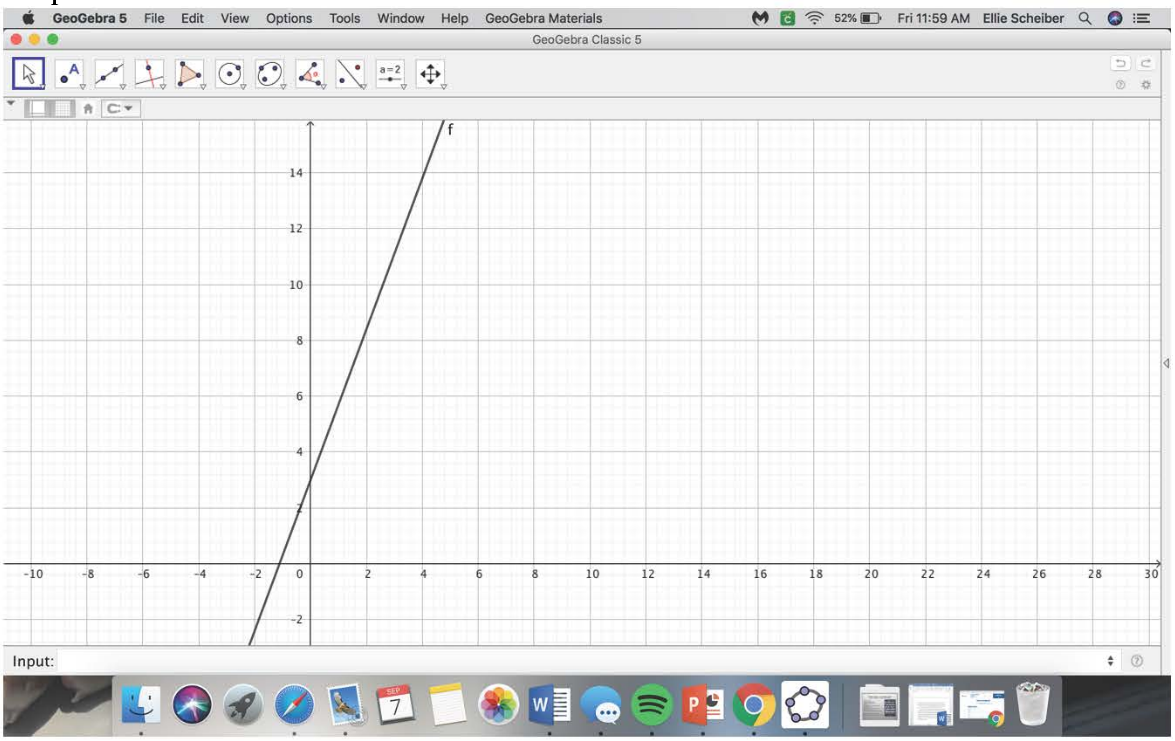
7. Using the information from the previous questions, determine the cost of your entire vacation. You will need to write three answers here: one for the scenario in which you take a cab from home to the vacation destination, one for the scenario in which you drive the entire way, and one for the scenario in which you ride in an airplane and then take a cab from the airport to the vacation destination.
   If I take a cab the entire way, my trip will cost a total of $7785. If I drive the entire way, my trip will cost a total of $2189.78. If I take an airplane to Orlando and then take a cab to Disney, my trip will cost a total of $3296.20.

8. Based on the information from Question 7, as well as your own feelings about travel, what is your preferred method of travel and why?
   The cheapest method of travel will be to drive myself. Although I would prefer to fly so that I do not have to drive for over 15 hours, I would rather save the extra money to spend on something else, like souvenirs! I will drive to Disney.

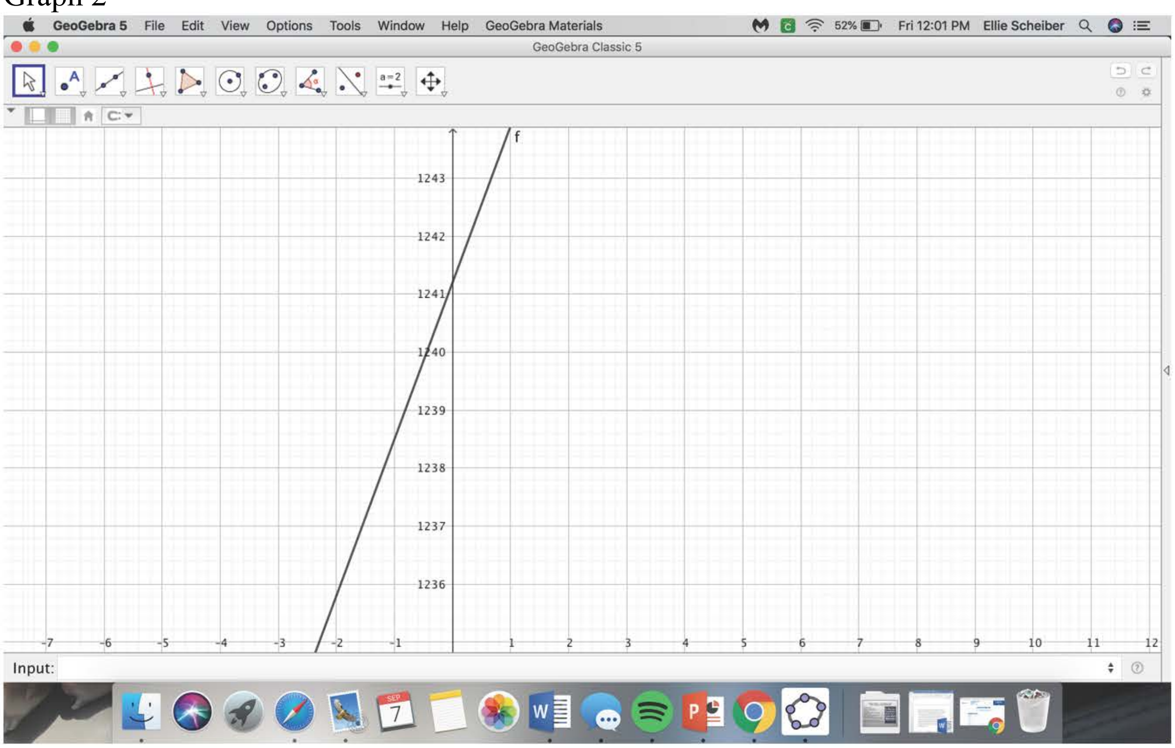
Planning a Vacation: Graphs

Name: Student

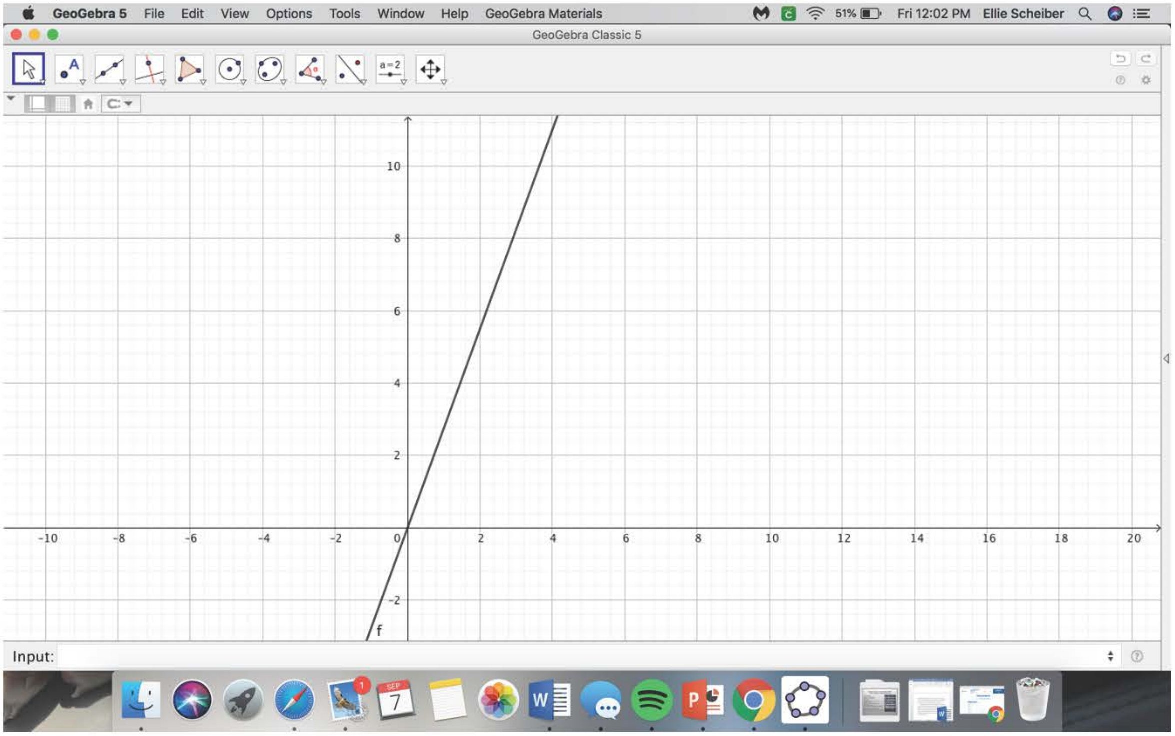
Graph 1



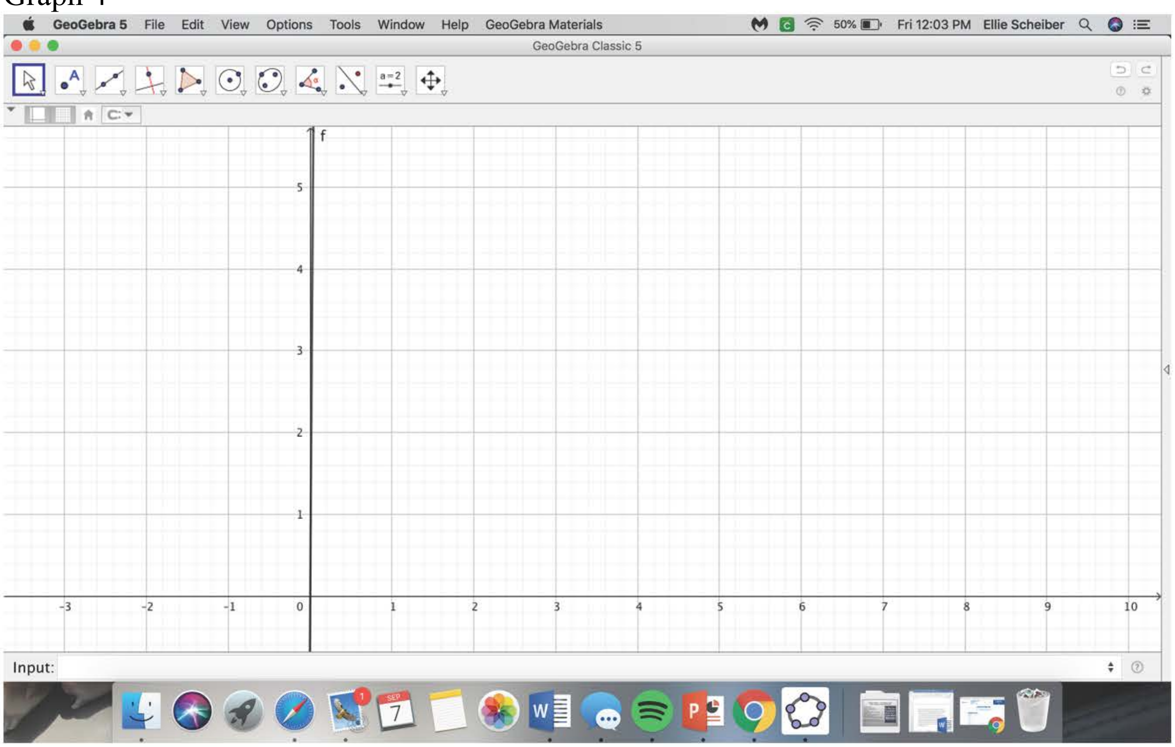
Graph 2



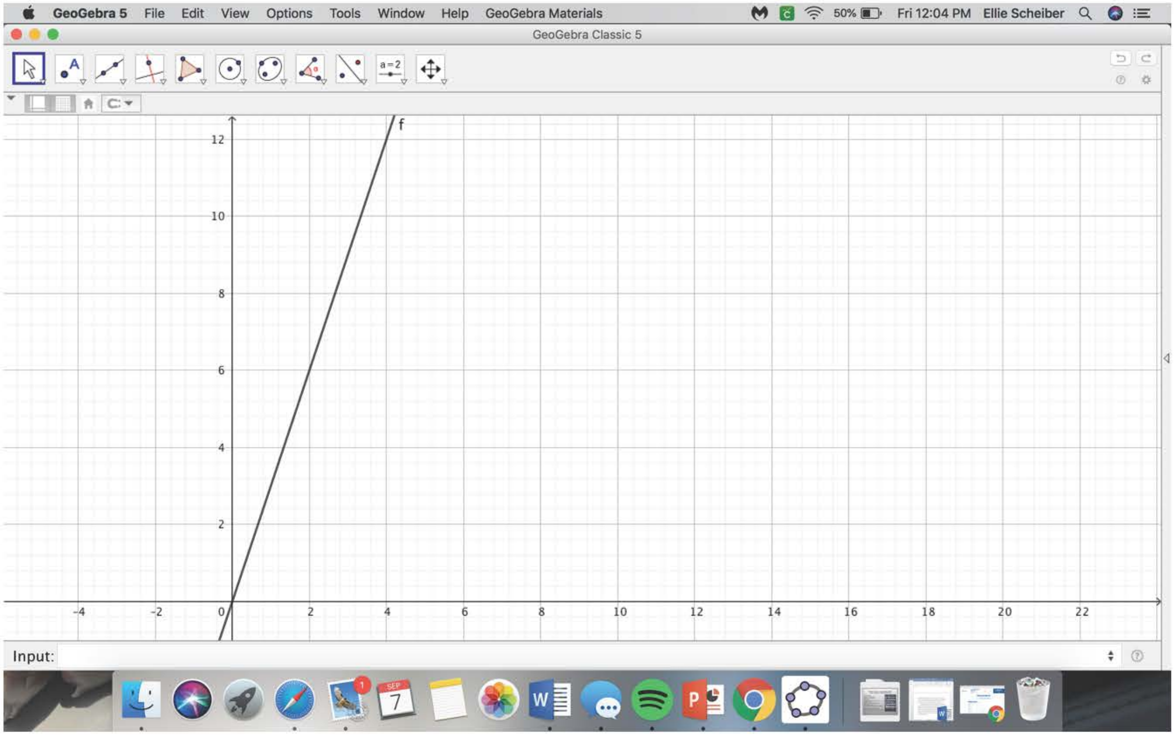
Graph 3



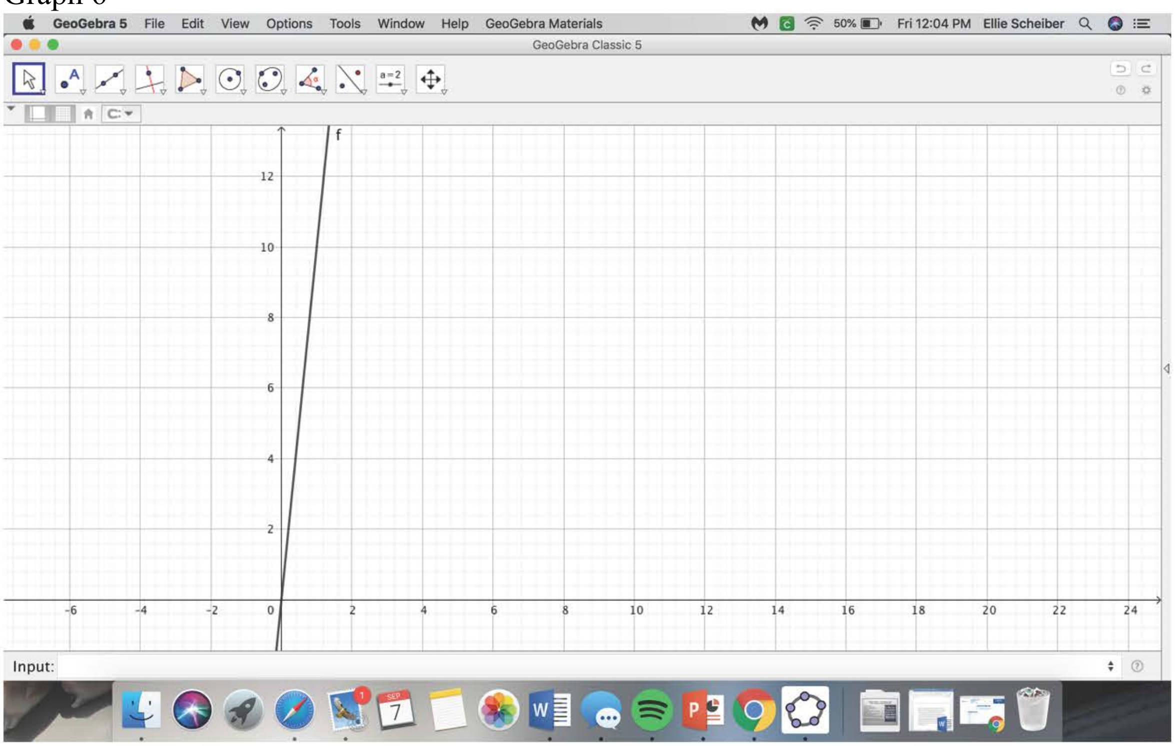
Graph 4



Graph 5



Graph 6



Blueprint for the Indiana ISTEP+ Grade 10 Math Assessment
(Beginning 2015-2016 School Year)

Reporting Category[1]	Standard	Standard Allocations[2]		Reporting Category Allocation
		Point Range	% Range[1]	Total Point Range
Number Sense, Expressions, and Computation (11 – 21%)	**AI.RNE.1** Real number systems	Assessed in the classroom		8 – 15
	AI.RNE.2 Operations with rational and irrational numbers	0-3	0-4 %	
	AI.RNE.3 Numeric expressions with positive rational	0-2	0-3 %	
	AI.RNE.4 Square roots of non-perfect square integers and algebraic monomials	0-4	0-5 %	
	AI.RNE.5 Algebraic rational expressions.	0-2	0-3 %	
	AI.RNE.6 Factoring polynomials	1-4	1-5 %	
	AI.RNE.7 Understanding polynomials	0-4	0-5 %	
	8.NS.1 Identification of rational and irrational numbers identification conversions	1-4	1-5 %	
	8.NS.2 Values of irrational numbers	0-2	0-3 %	
	8.NS.3 Properties of exponents	0-2	0-3 %	
	8.NS.4 Solutions to equations of the form $x^2 = p$	0-2	0-3 %	
	8.C.1 Real-world problems with rational numbers	0-3	0-4 %	
	8.C.2 Whole number quotients	Assessed in the classroom		
Geometry and Measurement (4-14%)	**8.GM.1** Attributes of three-dimensional geometric objects	1-4	1-5 %	3 – 10
	8.GM.2 Volume of cones, spheres, and pyramids and surface area of spheres	0-2	0-3 %	
	8.GM.3 Effects of rotations, reflections, and translations	Assessed in the classroom		
	8.GM.4 Congruent two-dimensional figures and transformations	0-3	0-4 %	

	8.GM.5 Similar two-dimensional figures and transformations	Assessed in the classroom		
	8.GM.6 Effects of transformations on two-dimensional figures using coordinates	0-2	0-3 %	
	8.GM.7 Inductive reasoning and the Pythagorean	Assessed in the classroom		
	8.GM.8 Pythagorean Theorem and side lengths	1-4	1-5 %	
	8.GM.9 Pythagorean Theorem and distance	0-3	0-4 %	
Data Analysis, Statistics, and Probability (9 – 19%)	**AI.DS.1** Sampling methods and bias	0-2	0-3 %	7-14
	AI.DS.2 Relationships of bivariate data on a scatter plot	Assessed in the classroom		
	AI.DS.3 Linear functions modeling bivariate data	0-4	0-5 %	
	AI.DS.4 Correlation and causation	0-2	0-3 %	
	AI.DS.5 Two-way frequency tables	Assessed in the classroom		
	AI.DS.6 Analyzing statistics and data	1-4	1-5 %	
	8.DSP.1 Patterns in scatterplots	1-5	1-7 %	
	8.DSP.2 Straight lines modeling scatterplots	Assessed in the classroom		
	8.DSP.3 Predictions from equations modeling linear relationships	2-5	3-7 %	
	8.DSP.4 Probability of compound events	Assessed in the classroom		
	8.DSP.5 Sample spaces and probabilities of compound events	0-2	0-3 %	
	8.DSP.6 multiplication counting principle	0-2	0-3 %	
Linear Equations, Inequalities, and Functions (28 – 38%)	**AI.L.1** Solving linear equations	0-4	0-5 %	20-28
	AI.L.2 Real-word problems and linear equations and inequalities	0-4	0-5 %	
	AI.L.3 Algebraic proportions	1-4	1-5 %	
	AI.L.4 Representing linear functions	1-6	1-8 %	
	AI.L.5 Real-world problems and linear functions	1-5	1-7 %	

	AI.L.6 Translating linear function equations	0-3	0-4 %	
	AI.L.7 Real-world problems and linear inequalities	0-5	0-7 %	
	AI.L.8 Compound linear inequalities	0-2	0-3 %	
	AI.L.9 Solving absolute value linear equations	Assessed in the classroom		
	AI.L.10 Graphing absolute value linear equations	Assessed in the classroom		
	AI.L.11 Solving for a specified variable	0-2	0-3 %	
	A1.F.1 Function domains and ranges	Assessed in the classroom		
	A1.F.2 Functional relationships in graphs	0-4	0-5 %	
	A1.F.3 Domain and range	0-2	0-3 %	
	A1.F.4 Function relationships and context	0-3	0-4 %	
	8.AF.1 Solving linear equations	Assessed in the classroom		
	8.AF.2 Number of solutions in linear equations	0-3	0-4 %	
	8.AF.3 Function ordered pairs	1-4	1-5 %	
	8.AF.4 Describing and sketching graphs	Assessed in the classroom		
	8.AF.5 Linear and nonlinear functions	1-4	1-5 %	
	8.AF.6 Modeling a linear relationship	0-4	0-5 %	
	8.AF.7 Comparing linear functions	1-4	1-5 %	
Systems of Equations and Inequalities (4 – 14%)	**AI.SEI.1** Solving pairs of linear equations by graphing	0-2	0-3 %	3 – 10
	AI.SEI.2 Solving pairs of linear equations by substitution	1-5	1-7 %	
	AI.SEI.3 Representing context using systems of linear equations	1-5	1-7 %	
	AI.SEI.4 Representing context using systems of linear inequalities	0-3	0-4 %	
	8.AF.8 Graphs of systems of linear equations	0-2	0-3 %	

Quadratic & Exponential Equations and Functions (5–15%)	**AI.QE.1** Comparing linear and exponential functions	1-4	1-5 %	4 – 11
	AI.QE.2 Modeling using exponential functions	Assessed in the classroom		
	AI.QE.3 Graphing exponential and quadratic functions	0-3	0-4 %	
	AI.QE.4 Solving quadratic functions	1-4	1-5 %	
	AI.QE.5 Modeling using quadratic functions	0-3	0-4 %	
	AI.QE.6 Factoring quadratic functions	1-4	1-5 %	
	AI.QE.7 Relationships of solutions of quadratic functions	0-3	0-4 %	
Mathematical Process[3] (4-14%)	**PS.1** Make sense of problems and persevere in solving them	3-10	4-14 %	3-10
	PS.2 Reason abstractly and quantitatively			
	PS.3 Construct viable arguments and critique the reasoning of others			
	PS.4 Model with mathematics			
	PS.5 Use appropriate tools strategically			
	PS.6 Attend to precision			
	PS.7 Look for and make use of structure			
	PS.8 Look for and express regularity in repeated reasoning			
Total Points Possible				71-73

[1]Percentages are based on the total points for the test, not the points for the reporting category.
[2]Standards with ranges that start at zero may not be tested every year.
[3]Mathematical Process standards are assessed in open ended items with a content standard.